James J. Hoorman
Cover Crops & Water Quality, Extension Educator, Ohio State University

Solving Soil Compaction with Cover Crops

For years, farmers and scientist have been trying to solve the mystery about soil compaction. Every soil engineer and equipment dealer has tried to come up with the perfect tool to "fix" the soil to alleviate soil compaction. Some tools work temporarily but none actually solve the problem long-term. Today we have a much better picture of what causes soil compaction and how to fix the problem.

Subsoil tillage has been used to alleviate soil compaction. Subsoilers are typically operated at depths of 12 to 18 inches to loosen the soil, alleviate compaction, and increase water infiltration and aeration. Subsoiling usually increases crop yields but the effects may only be temporary as the soil re-compacts due to equipment traffic. When subsoiling removes a hard pan, traffic must be controlled or soil compaction will reoccur. If the soil is subsoiled when the soil is wet, additional compaction may occur and subsoiling in dry conditions requires more fuel. The fuel, labor, equipment, and time to subsoil; makes it an expensive operation, especially when the results may only last a year or two. The problem is that we were trying to engineer a solution with steel when we should have been growing a solution with plants!

Low soil organic matter (SOM) levels make the soil more susceptible to soil compaction. Organic residues on the soil surface have been shown to cushion the effects of soil compaction. Surface organic residues have the ability to be compressed but they also retain their shape and structure once the traffic has passed. Like a sponge, the organic matter is compressed and then springs back to its normal shape. Organic residues in the soil profile may be even more important than surface organic residues. Organic matter and plant debris around soil particles keeps soil particles from compacting by cushioning soil particles with organic residues. Organic matter binds microaggregates and macroaggregates in the soil promoting better aeration, water infiltration and soil tilth.

Every farmer with heavy clay compacted soils would like to have some sand in his fields, so here is how you can improve your soil. Microaggregates are the smallest soil particles around 25-250 uM in size. Microaggregates include clay microstructures, silt-size microaggregates, particulate organic matter, plant and fungus debris, and mycorrhizal fungus hyphae. These particles are stable in size and resist breaking down, even under heavy traffic. Macroaggregates are greater than 250 uM in size and give soil its structure and allow air and water infiltration. Compacted soils tend to have more microaggregates than macroaggregates. Macroaggregates are about the size of small sand particles.

Macroaggregates are formed and stabilized by polysaccharides from plant exudates and mycorrhizal fungus. A polysaccharide is created by combining protein from mycorrhizal fungus with sugar from plant root exudates. Glomalin is one type of polysaccharide which is released when the fungal hyphae dies. Glomalin represents 1-5% of total organic matter in the soil. Glomalin initially coats the plant roots and then coats soil particles. Glomalin acts like a glue to

cement microaggregates together to form macroaggregates and improve soil structure. Basically the reason soils compact is because they lack the glue to hold the soil particles together, something that no piece of steel can produce.

Tillage tends to decrease polysaccharide and glomalin production by increasing the oxygen content of soils, stimulating bacteria growth, which consume these natural soil glues. In order to maintain a constant supply of glue production, active living roots and fungus must live in the soil. Tillage kills off the fungus and increases bacteria growth decreasing glue production..

Two examples will illustrate this point. Every farmer has seen a field worked too fine (microaggregates), especially on clay soils. When it rains, the soil gets hard and sets up like cement. This soil lacks the glue from the root exudates and the fungus to have good soil structure. However, dig up a pasture, a long-term hay field, or even grass from your lawn and compare it to soil from a conventional cultivated field. The vegetated soil has large soil peds (macroaggregates) that are soft and crumble between your fingers. Tillage destroys these peds because the glue is consumed by increasing hungry bacteria populations stimulated by tillage.

So why does our soils compact? First, tillage destroys macroaggregates and stimulates a decrease in the production of natural soil glues (root exudates and polysaccharides) in the soil. Heavy machinery then allows the microaggregates to set up like cement and form hard soils. However, there is another issue called crop rotation. In a typical corn-soybean rotation, active roots are present only 32% of the year, leaving soils devoid of active growing roots 68% of the time. Without active growing roots, macropores and active carbon (glue) are not produced, so the soil started to compact from gravity, rainfall, and/or heavy traffic. **Thus, soil compaction is a biological problem related to the lack of active living roots and fungus in the soil.** Farm fields that have been excessively tilled tend to crust, seal and compact more than no-till fields with a living crop. The solution to soil compaction and better crops yields is simply trying to mimic natural biological cycles by using continuous no-till with a living crop year round. Cover crops increase the amount of active living roots in the soil and improves soil tilth, which is something no piece of steel can do!

What is a Clod?

How many times have you heard a farmer complain about cloddy fields? Clods are a manmade and do not usually exist in the natural biological world. Bricks are made of clay and are formed by taking wet clay, heating it up, and baking it in an oven. Clods are formed the same way by exposing clay to sunlight, heating and drying the soil, and burning up (oxidizing) the soil organic matter until the soil get hard as a brick. What do we call a brick on top of the soil? We call it a clod! Google ohioline: The Biology of Soil Compaction for more information.

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